AN ANALYSIS OF THE VENEZUELAN DoD BUDGET PROCESS.

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THESIS

AN ANALYSIS OF THE VENEZUELAN
DOD BUDGET PROCESS

by

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September 1977

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by

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I. INTRODUCTION

A. BACKGROUND

"The elements of economic choice in the military resource allocation problem, whether its solution requires advanced mathematics, high speed computing equipment, or just straight hard thinking, are the following:

(1) An objective or objectives. What military (or other national) aim or aims are we trying to accomplish with the forces, equipments, projects, or tactics that the analysis is designed to compare ?, choice of objectives is fundamental.

(2) Alternatives. By what alternative forces, equipments, projects tactics and so on, may the objective be accomplished ?, The alternatives are frequently referred to as systems, because each combines all the elements - men, machines, and the tactics of their employment -needed to accomplish the objective.

(3) Costs or resources used. Each alternative method of accomplishing the objective, or in other words each system, involves the incurring of certain costs or the using up of certain resources.

(4) A model or models. Models are abstract representations of reality which help us to perceive significant relations in the real world, to manipulate them, and thereby predict others.

(5) A criterion. By "criterion" we mean the test by which we choose one alternative or system rather than another".[Ref.1,pag.118]

Within this quote lies a structure for choice as old as the ancient Greeks, namely the steps of the scientific method:(1) what is the objective, (2) what are the alternatives, (3) measurements to compare the alternatives, (4) thinking structures to abstract the problem and, (5) a decision based on a criterion. This method is a structure which can be a basis for organizational control by the budgeting system.

In everyday speech, the words "budget" and "budgeting" carry largely negative connotations, evoking images of unwelcome financial constraints and of dreary numerical tabulations. Yet despite its lack of glamour, budgeting is an essential tool for the management of large enterprises . It is first and foremost a planning process, through which the manager allocates the available resources to the working units of his organization. Ideally, a budget should convert goals, programs, and priorities into monetary terms following rational economic analysis and decision on the optimum means of accomplishing an agency's objectives. Moreover, budgeting is an important device for the review and control of the activities of the component parts of an organization, to the end that over-all purposes and not parochial ones are served. Thus, budgeting is inextricably linked to the formulation of policy and the orderly execution of programs.

The military services always (and properly) want more; the economizers (congressmen) always (and also properly) offer resistance, or try to impose reductions. But once the budget has been determined, there is no longer conflict of interest.

In fact, the choices that maximize military capability for a given budget are the same choices that minimize the cost of attaining that capability.

This thesis examines the budgetary process in the Venezuelan DoD, some of its legal aspects , and, analyses in a linear model Congressional and Services behavior during the request and appropriation phases of the budget from 1962 till 1976. It also intends to formulate a model utilized in the U.S.A.'s DoD for budget preparation known as Planning Programming and Budgeting system (PPBS) as an alternative model for the budget preparation applicable to the Venezuelan Armed Forces, looking in some detail at its structural aspects and how it is related to the organization by means of the concept called Organizational Development.

B. VENEZUELAN BUDGET SINCE 1962

The Venezuelan Constitution of 1961 allows for a dual system of ordinary and extraordinary expenditures but in doing so it expressly requires Congressional authorization either directly or through ad hoc entities such as the Delegated Commission (an extraordinary governmental body formed by the President, the Vice-President, and 21 members of both Houses who represent Congress' political composition and who are convened when the Congress is not in session). The Constitution sets forth guidelines and limitations; one of these guidelines requires that no expenditure can be funded by the National Treasury unless provided for in the budget law. More specific guidelines and limitations on preparing the annual budget laws are set forth by the Organic Law of the Treasury of 1961, which serves as the main body of legislation not only for the activities of the Ministry of the Treasury but also for budgetmaking and control, regardless of ministry or agency.

From this statute it becomes apparent that several governmental agencies play important roles in deciding the allocation of governmental expenditures. One of these is the Council of the Budget, an advisory body presided over by the Minister of the Treasury and formed by him and thirteen other members, two appointed by the Minister of the Treasury, and one by each other minister, and others appointed by the autonomous agencies. Another is the Office of the Comptroller General, whose function it is to check carefully the formal or legal regularity of appropriations and acquisitions . In relation to military acquisitions the Superior Junta of National Armed Forces acts as an advisory body in this respect, but there does not exist any legal or

established procedure which regulates that activity.

The "additional credits", a budgetary practice that is used in order to engage in extraordinary acquisitions programs, thus circumventing some of the administrative and Congressional checks, is permitted by law.

Purchases of military equipment and supplies are expressly assigned a major portion of Ministry of Defense annual allotments.

1. The Constitution of 1961

The Venezuelan Constitution of 1961 provides numerous guidelines for governmental budgeting and spending. Some of these are directed to the President of the Republic who, as Commander-in-Chief of the Armed Forces and head administrator of the public treasury, stands in a key position in terms of planning and executing large expenditures[1]. The President oversees the budget preparation and expenditure process as it develops in the different ministries, and specifically in the Ministry of the Treasury [Ref. 2 ,art. 193,227,228]. The president may decree credits, above and beyond those listed in the budget if so authorized by Congress in a joint session or by the so-called "delegated commission" (comision delegada) [Ref. 2 ,art.190(14)].

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[1] For Presidential powers under the Venezuelan 1961 Constitution, see Constituciones de Venezuela, Constitucion de 1961, Article 190, Sections 3 and 12; hereafter cited as Constitution

Budgetary legislation is initiated in the Chamber of Deputies, which is responsible for the introduction and initial discussion of any enactment affecting the fiscal structure of the Nation [Ref. 2, art.153(1)], the timing and manner of presentation of the budget are left to the Organic Law of the Budget (See the Organic Law of the Treasury of 1961 in next paragraph), but its general principles are carefully outlined in the constitutional text; some of the most significant for the purpose of this thesis will be listed below:

1. No expenditure funded by the National Treasury may be made if not provided for in the budget law. Additional credits may be decreed only for those necessary and unforeseen expenses or those whose allotments were insufficient, as long as the Treasury has enough means to meet the new expenditures. In this connection, it is necessary to obtain the favorable vote of the Council of Ministers and the authorization of the Congress in a joint session or, when it can not meet, the authorization of the Delegated Commission [Ref. 2, art.227].

2. Congress may alter the amounts in budgetary entries but it may not authorize expenditures which exceed the total expected revenues [Ref.2, art.228].

3. The office of the Comptroller General is directed to inspect and audit governmental income and expenditures, as an auxiliary agency of the Congress but with autonomous functions.

2. The Organic Law of the Treasury of 1961

The Organic Law of the Treasury of 1961 (Ley Organica de la Hacienda Publica Nacional) comprises some of the most important aspects of governmental acquisitions in Venezuela. It regulates the activity of the Ministry of the Treasury, and in doing so includes the basic rules on budgetmaking and control. In other words, this law serves as the Organic Law of the Ministry as well as of the Budget and the Office of the Comptroller General.

The fiscal year starts in Venezuela on the 1st of January and ends on the 31st of December of each year. The various Ministers are instructed to submit to the Council of the Budget (Consejo del Presupuesto) within the first 15 days of June the detailed list of expected expenditures and their justifications.

The Budget Council is an advisory body presided over, ex officio, by the Minister of the Treasury and formed by him and thirteen other members (2 appointed by the Minister of Treasury, one by each other Minister, and one by the autonomous agencies (organismos autonomos). It is empowered to consider the various proposals, and may object to submitted expenditures, first by sending a detailed objection in writing to the submitting Minister or Ministers, subsequently by reporting to the Council of Ministers for final decision concerning the presentation to Congress. The final draft of the Budget must be submitted to Congress by the Minister of the Treasury no later than the 2nd of October of each year.

3. The Budget Format

The DoD budget request's format as any other department within the Executive branch is divided into chapters[2] (capitulos) classified in accordance with their origen and subject matter. Chapters, in turn, are divided into entries (objetos) and sub-entries (sub-objetos), each entry listing the total amounts for sub-entries. Generally, the entries and sub-entries have, since 1962, retained the same or similar pre-assigned number, thus allowing a quicker identification by the reader. For example, in the 1966 Budget, Chapter 12 is devoted to expenditures by the General Command of the Air Force (Comandancia General de la Aviacion). In it, entry 50 is assigned to acquisition of machinery and equipment, subentry 500 to major parts acquisitions, 560 to equipment for national defense and security. By looking for these entries in preceding or subsequent chapters, dealing, say, with the General Command of the National Guard (Chapter 13), an adequate tabulation of the total expenditures for the above-listed items may be made. A breakdown of Major Defense Programs and an example of the structural appropriation categories are illustrated in Fig 1.

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[2] Since 1970, DoD changed from chapters to programs as the new bases for the budget structural format.

A. MAJOR DEFENSE PROGRAMS

01. Central Services
02. Planning, Consulting, and Control
03. Land Defense
04. Naval Defense
05. Air Defense
06. National Guard
07. Presidential Guard
08. Military Instruction
09. Support Services
10. Social Security
11. Public Sector Support

B. AN STRUCTURAL APPROPRIATION FORMAT

PROGRAM 04 - NAVAL DEFENSE

ENTRY 50 - Material and Systems Procurement

GENERIC SUB-ENTRY 500
Major spare parts

SPECIFIC SUB-ENTRY 503
Major spares for Communication devices

SPECIFIC SUB-ENTRY 506
Major spares for Defense equipments

GENERIC SUB-ENTRY 530
Communication Sytems

SPECIFIC SUB-ENTRY 531
Tele-communication systems

SPECIFIC SUB-ENTRY 532
Visual communication systems

Figure 1 - VENEZUELAN MAJOR DEFENSE PROGRAMS AND BUDGET FORMAT

It is important to notice here that according to Novick [Ref.22, p.530] the term program means the output or ultimate goal of many interdependent activities; for example, the combination of equipment, people, real estate, and related activities necessary for a military mission such as the strategic bombardment or continental defense. In the Venezuelan case, the term program generally doesn't accord with Novick's definition of a program; as an example note that programs one(01) and seven(07) don't relate a combination of activities to meet an end objective within DoD's established mission (see figure one).

A careful examination of program 04 (Naval Defense) shows a typical example of either double counting or a great problem to the office in charge of keeping track of expenditures; as can be seen in the Generic Sub - Entry 500 - Specific Sub - Entry 503 and Generic Sub - Entry 530 including all of its specific Sub - Entries; they refer to Communication Systems (including spare parts) as if they were separate items in the accounting records.

II. MODEL DESCRIPTION

The mathematical structures suggested in this thesis for modeling congressional behavior when considering DoD budget requests are similar to those used by Davis, Dempster and Wildavsky[3] to describe the congressional/non-defense agency budgetary process. Their basic structure suggests a set of possible decision rules that are linear, stable over periods of time, stochastic, and strategic in nature[4]. In reality, they may be thought of as "as if" models in that realizing a good fit for a given model means only that the actual behavior of the participants appears to follow the relationship suggested by the model. The models do not attempt to describe the decision making process in detail but rather in an input-output sense where the President's budget submission may be considered to be the input variables and final congressional appropriations as the output quantity.

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[3] These three authors argue that there are striking regularities in the U.S.A. budgetary process that conforms with these models

[4] See appendix of Ref. 14 for an explanation of these terms

For each model the constant or intercept term, normally found in a linear model, is suppressed in order to interpret the coefficient(s) as increments or percentage figures. Although intuitively appealing, models of this type have somewhat different statistical properties and thereby present some difficulty in empirical testing and evaluation (see Appendix A).

Each model also contains a random error term which accounts for events that might otherwise upset the simplicity of the model. Davis, Dempster, and Wildavsky describe such events in the following manner:

> "Occasionally, world events take an unexpected turn, a new President occupies the White House, some agencies act with exceptional zeal, others suffer drastic losses of confidence on the part of the appropriations subcommittees, and so on." [Ref.14, pag.531].

For each of the models the following definition of variables apply:

X_t - agency funding request in year t as contained in the President's budget

Y_t - final Congressional appropriations for a given request in year t. Supplemental appropriations are not included[5]

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[5] It is felt that omitting supplemental budget requests will not significantly distort study results.

X_{t-1} - agency funding request in year t-1

Y_{t-1} - final Congressional appropriations for a request in year t-1

ε_t - stochastic error or disturbance term. ε_t is usually assumed to be normally distributed with mean zero and constant variance σ^2 with the sequence (ε_t) being independently and identically distributed random variates

A. SERVICE DECISION MODELS

Before attempting to model Congressional reaction toward a submitted defense budget it is necessary to investigate different possible strategies that the services may be using to formulate their requests, for the Congress may know the specific decision rule being used by the services and react accordingly.

The first model attempts to describe a service's behavior when, though convinced of the worth of its programs, it realizes that extraordinarily large or small requests tend to precipitate unfavorable Congressional reaction. Therefore, in an effort to secure the necessary funding, the agency will tend to request a percentage of the previous year's appropriation. This percentage will be stable over time. However, favorable (unfavorable) events may generate requests that are larger (smaller) than normally submitted. Decisions made in this manner may be represented mathematically as:

$$X_t = \beta_0 Y_{t-1} + \varepsilon_t \qquad (R1)$$

where β_0 represents the percentage of the previous appropriation requested and ε_t the random error term

The second request model attempts to explain the actions of the service that is convinced of the worth of its programs regardless of previous Congressional action. This type of behavior is especially appealing when the Congress has confidence in the agency and tends to appropriate amounts equal to or greater than the request submitted.

Accordingly, the annual request for such a program should be a fairly stable percentage of the previous year's request plus an error term. Thus

$$X_t = \beta_1 X_{t-1} + \varepsilon_t \qquad (R2)$$

may be used to investigate such behavior. In the absence of exogenous events, the request in year t should be greater than the request in the previous year (t-1).

Finally, a service may desire to smooth out its stream of appropriations by taking into account the difference between its request and appropriation in the previous year. This difference may be thought of as a barometer - an indication of how well past request(s) have been received in order to determine which areas to emphasize in the present budget. Such behavior may be expressed as

$$X_t = \beta_2 Y_{t-1} + \beta_3 (Y_{t-1} - X_{t-1}) + \varepsilon_t \qquad (R3)$$

where β_2 represents the percentage of the previous year's appropriation being requested and β_3 the percentage difference between last year's appropriation and request desired.

B. CONGRESSIONAL DECISION MODELS

In order to investigate the many possible decision strategies that the Congress may have used in determining funding level, a series of models were postulated. Each model attempts to link expressed congressional feelings and desires with possible behavior.

The first model considers Congressional response to a defense agency to be a function of that agency's request.

This type of behavior may result if the Congress feels that the agency's requests are realistic and, as a result, a fairly stable indication of that agency's needs to carry out existing and planned programs. Should this be the case then Congress may respond by appropriating a relatively fixed percentage of the request. Such behavior may be expressed mathematically as

$$Y_t = \alpha_0 X_t + \varepsilon_t \qquad \text{(A1)}$$

where α_0 represents the percentage appropriated and ε_t the stochastic error term.

Next, suppose that although Congress usually grants a fixed percentage of the agency request, it sometimes happens that this amount represents an expenditure which extends the agency's programs either above or below the size desired by Congress. Such a situation could result when an agency follows Presidential aims which differ significantly from those of the Congress. In this situation Congress may appropriate a sum different from its usual percentage. Then, in the following year, should agency and Congressional aims become more aligned (X_t approximately equal to Y_{t-1}) the Congress may attempt to make allowances for the deviation out of the current year appropriation. If α_1 represents the usual percentage appropriated then

$$Y_t = \alpha_1 X_t + \varepsilon_t$$

may be used to describe such behavior; where ν_t is the stochastic disturbance term that takes on unusually large positive or negative values in accordance with the first-order Markov scheme

$$\nu_t = \alpha_2 \nu_{t-1} + \varepsilon_t$$

Substitution results in

$$Y_t = \alpha_1 X_t + \alpha_2(Y_{t-1} - \alpha_1 X_{t-1}) + \varepsilon_t \qquad \text{(A2)}$$

the second Congressional decision model.

Finally, specialization by subcommittee (Camaras) members allows some members of Congress to have substantial knowledge of the military services and their budget formulation. This knowledge may aid the appropriation subcommittees in identifying the decision model used by the services to formulate their request or proposed expansion for a given year. For example, if Congress knows that decision model R1 was used to formulate agency requests then the subsequent appropriation decision model may include this information. The model

$$Y_t = \alpha_3 X_t + \alpha_4 \lambda_t + \varepsilon_t$$

may be used to describe such behavior when $\lambda_t = X_t - \beta_0 Y_{t-1}$ Substitution for λ_t provides for the third decision model

$$Y_t = \alpha_3 X_t + \alpha_4(X_t - \beta_0 Y_{t-1}) + \varepsilon_t \qquad \text{(A3)}$$

On the other hand, should the appropriation committee members be concerned with program expansion rate, the expression

$$Y_t = \alpha_5 X_t + \alpha_6 (X_t - X_{t-1}) + \varepsilon_t \qquad (A4)$$

may best describe such concern. The variable $(X_t - X_{t-1})$ should provide a reasonable indication of agency desires to expand or reduce its sphere of influence in a particular field.

The series of models postulated for this study of Congressional-DoD interaction in no way exhausts the list of possible models; you can use the log-linear model or a combination of R2 and R3 as the agency decision rule; this author considers that the models suggested in this thesis are sufficient to establish conclusive results. They are, however, consistent with the data available and maintain the concept of incrementalism and simple decision rules suggested by Davis, Dempster, and Wildavsky. It should be noted that these models do not distinguish between actions initiated by the House (Diputados) and Senate (Senadores) Armed Services Appropriations Committees (Comision de Defensa del Congreso).

C. MODEL SELECTION CRITERION

Davis, Dempster, and Wildavsky have used the adjusted coefficient of determination (R^2) to judge the adequacy of the fit of the model to the data [Ref.14, p. 274]. Stromberg has noted that there are methodological problems with linear regression without a constant term and that "R^2 is not an especially desirable measure of goodness fit." As an alternate measure of model fit Stromberg proposed the used of "W^2 or proportion of variation explained"[Ref.9, p. 21-24].

To acquaint the reader with the methodological differences between linear regression with and without a constant term a general review of linear regression theory for models with a constant term and its validity for models with a suppressed constant is included in Appendix A. Appendix B documents those statistical tests to be used for testing and evaluation of the models proposed in the previous sections. Particular attention is given to identifying the impact of suppressing the constant term on test validity. Finally, Appendix C discusses selected nonparametric criteria that were employed when necessary parametric assumptions were questionable.

D. DATA SOURCES

In order to empirically test the decision models presented in Chapter II a data base that included the previous and current year's request and appropriation was needed. Data sources available were:

a. summary tables prepared by the Treasury Ministry-Office of the Budget presenting the different Ministries' requests before the Congress [Ref.20].

b. summary tables prepared by DoD and presented to the Ministry of the Treasury every year; FYs 1962-1976 [Ref.21].

Utilizing the information available in these documents sufficient data to test the hypothesized decision models were compiled. Figure 2 shows the data in constant 1972 U.S.A. dollars.

Year	DoD Request	Appropriated by Congress	Difference	Arms Procurement
1962	267.62	281.49	+13.87	
1963	282.46	302.13	+19.67	
1964	273.64	285.85	+12.21	
1965	293.24	303.19	+19.95	4.60
1966	281.26	291.60	+10.34	12.22
1967	285.77	264.25	-21.52	17.06
1968	278.86	282.16	+ 3.30	18.84
1969	267.41	268.94	+ 1.53	11.79
1970	257.42	257.94	+ 0.52	9.64
1971	262.17	331.13	+68.96	66.88 (*)
1972	289.89	289.94	+ 0.05	51.65
1973	291.02	297.62	+ 6.60	62.39
1974	289.14	290.00	+ 0.86	125.20 (*)
1975	378.80	380.82	+ 2.02	59.46 (*)
1976	298.96	314.73	+15.77	

(*) Not requested by normal budget presentation

Data in 1972 constant U.S.A. millions of dollars

Figure 2 - VENEZUELAN DoD TREND FROM 1962 TILL 1976

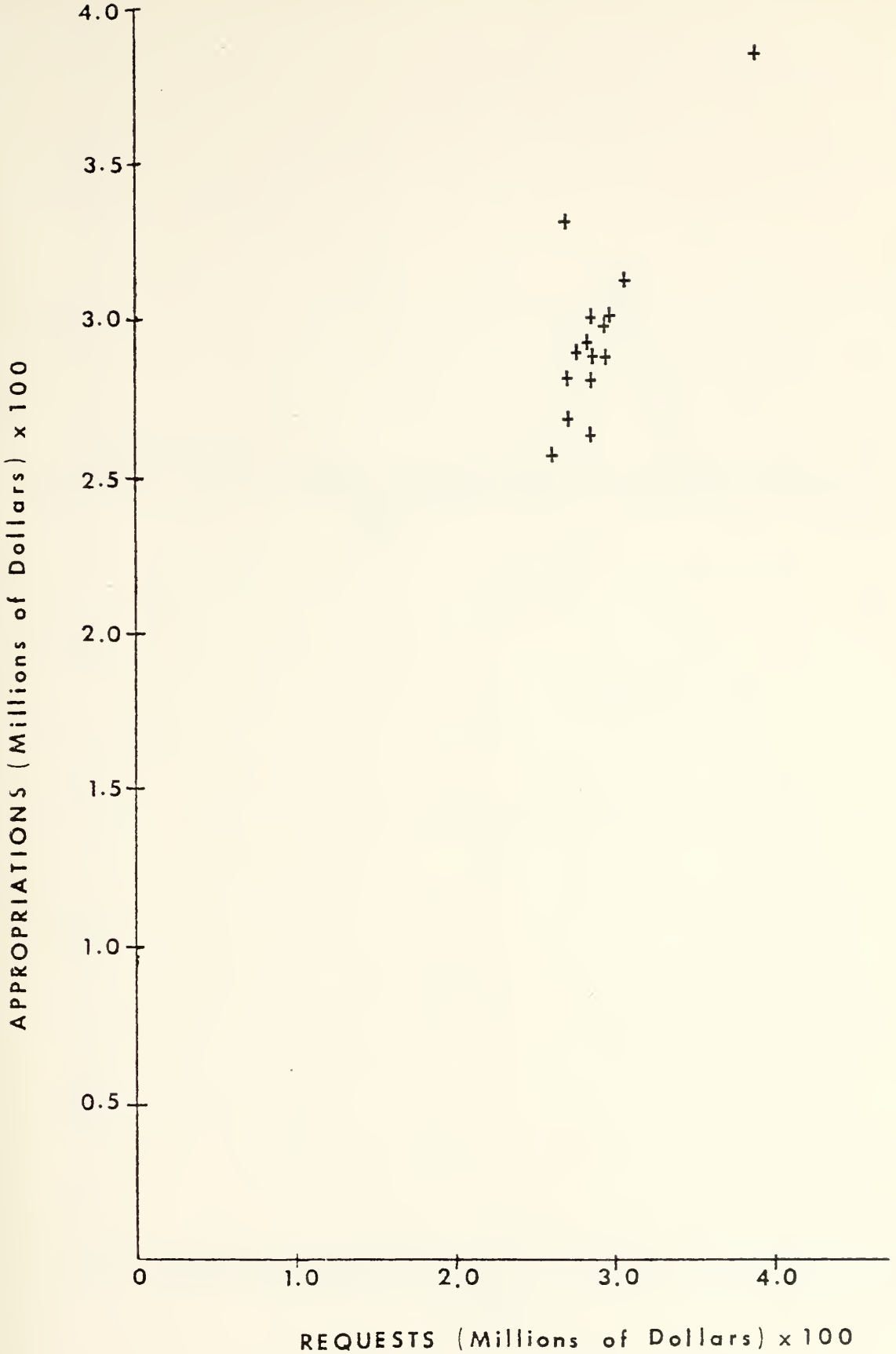

Figure 3 - APPROPRIATIONS vs REQUESTS, DoD: FYs 1962 to 1976

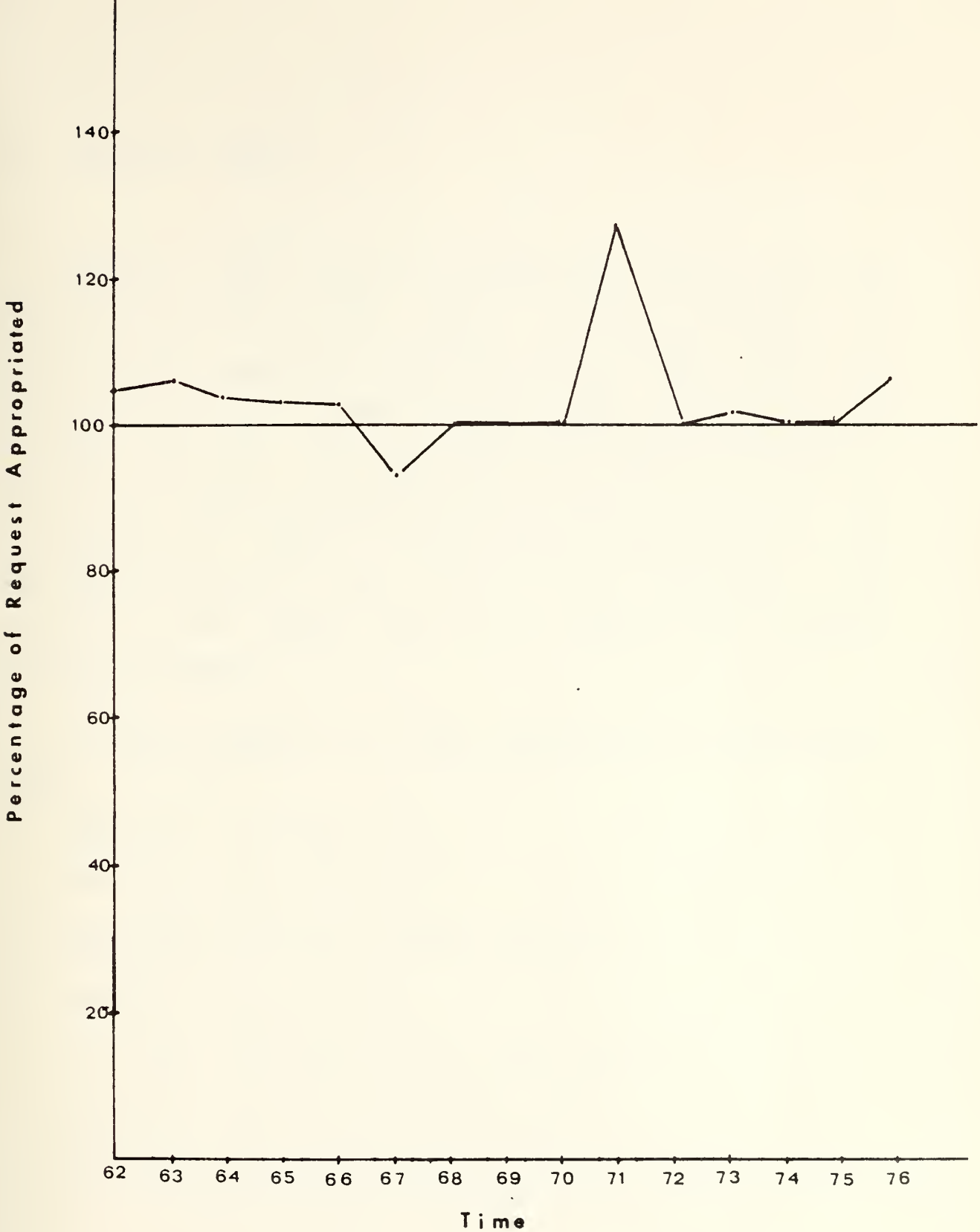

Figure 4 - PERCENT of REQUEST APPROPRIATED vs TIME; DoD: FYs 1962 to 1976

E. EMPIRICAL RESULTS

Multiple linear regression analysis was used to test the postulated decision rules using the data available. To perform the regression analysis the BIOMED series of statistical programs on simple and multiple regression was chosen. When the BIOMED programs are used under the assumption of zero intercept all variances, covariances, standard deviations, and correlations are computed about the origin vice the regression line (see BMDP1R in Ref.10). The consequences of such a computational procedure have been outlined in chapter II and, as such, were considered when selecting those models that best describe the defense budgetary process.

As they appeared in their structural form the models were:

Model R1 $X_t = \beta_0 Y_{t-1} + \varepsilon_t$

Model R2 $X_t = \beta_1 X_{t-1} + \varepsilon_t$

Model R3 $X_t = \beta_2 Y_{t-1} + \beta_3 (Y_{t-1} - X_{t-1}) + \varepsilon_t$

Model A1 $Y_t = \alpha_0 X_t + \varepsilon_t$

Model A2 $Y_t = \alpha_1 X_t + \alpha_2 (Y_{t-1} - \alpha_1 X_{t-1}) + \varepsilon_t$

Model A3 $Y_t = \alpha_3 X_t + \alpha_4 (X_t - \beta_0 Y_{t-1}) + \varepsilon_t$

Model A4 $Y_t = \alpha_5 X_t + \alpha_6 (X_t - X_{t-1}) + \varepsilon_t$

where: X_t = funding request for year t
X_{t-1} = funding request for year t-1
Y_t = appropriation for year t
Y_{t-1} = appropriation for year t-1
ε_t = stochastic error term

In this form all models except A2 and A3 were compatible with linear regression format. For A2 the following transformation of variable was necessary:

$$Y_t = \alpha_1 X_t + \alpha_2 (Y_{t-1} - \alpha_1 X_{t-1}) + \varepsilon_t$$

$$= \alpha_1 X_t + \alpha_2 Y_{t-1} - \alpha' X_{t-1} + \varepsilon_t \qquad (A2^*)$$

where $\alpha' = \alpha_2 \times \alpha_1$

The estimated coefficients ($\hat{\alpha}_1$ and $\hat{\alpha}_2$) are consistent in a statistical sense and unbiased but may be unstable (vary with sample size) should the variables Y_{t-1} and X_{t-1} be highly correlated [Ref. 7, pag.159-168].

For model A3 the variable $(X_t - \beta_0 Y_{t-1})$ was estimated by direct substitution of the computed residual from model R1, i.e.

$$Y_t = \alpha_3 X_t + \alpha_4 [\varepsilon_t (R1)] + \varepsilon_t \qquad (A3^*)$$

Johnston [Ref. 7, pag.376-380] has pointed out that $\hat{\alpha}_3$ and $\hat{\alpha}_4$ will be unbiased, maximun-likelihood estimates of α_3 and α_4 if $\varepsilon_t (R1)$ is normally distributed.

These models (R1, R2, R3, A1, A2*, A3*, and A4) were applied to the data; the results of which are included in Appendix D- Tables I and II. In the case of A2* the

coefficients have been transformed back into their structural form.

Of primary importance in deciding which model best fits the data is the impact of suppressing the constant term. For this end, $\bar{\varepsilon} = \frac{1}{n} \sum_{i=1}^{n} \varepsilon_i$ (where ε_i is the difference between the i^{th} actual and estimated request or appropriation) was computed for each model. For linear models with a constant term $\sum_{i=1}^{n} \varepsilon_i$ will be zero. For the suppressed constant models $\sum_{i=1}^{n} \varepsilon_i$ will be zero if and only if the data falls in a symmetric pattern about the regression line. Other relevant statistics considered were coefficient of variation (CV) and standard error (SE).

The statistical significance of the estimated coefficients was tested using the two sided "t" test at the 0.05 level of significance. Those coefficients annotated by an asterisk (*) in tables I and II were not found to be statistically significant, that is, it was not possible to reject the hypothesis that the coefficient was equal to zero.

Application of the above criteria made possible the selection of the following models as being most representative of the defense budgetary process.

1. Model R1

Sample size = 14

$$X_t = \underset{(29.581)}{0.959Y^{6}_{t-1}} + \varepsilon_t ; \quad CV = 0.1261$$

2. Model R2

Sample size = 14

$$X_t = \underset{(30.314)}{1.001X_{t-1}} + \varepsilon_t ; \quad CV = 0.1231$$

3. Model A1

Sample size = 15

$$Y_t = \underset{(59.624)}{1.032X_t} + \varepsilon_t ; \quad CV = 0.0651$$

Davis, Dempster, and Wildavsky found that model A1 (using current year request to explain current year appropriation) realized the best fit; a result that was also noted in this study. Models R1 and R2 realized the best fit explaining service behavior, which also resulted in an incremental type request.

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[6] The number in parenthesis below each coefficient is the computed "t" statistic for that coefficient.

This result suggests that the defense appropriation process may be modelled by simple (basically incremental) decision rules as argued by Davis, Dempster, and Wildavsky in their studies of Congressional behavior and empirical results for the non-defense budgetary process.

III. PPBS CYCLE IN THE U.S.A. DEPARTMENT OF DEFENSE

Prior tc formal budget submission to the Congress as an integral part of the total Federal Budget, the DoD budget undergoes approximately 18 months of development and review within the Defense Department. The preparation process, knowm as Planning, Programming and Budgeting system or PPBS, includes three distinct phases: planning (six months); programming (nine months); and budgeting (three months).

The planning phase primarily involves threat analysis and force level requirements determination to counter these threats, first unconstrained by cost and then under tentative fiscal constraints established by the Office of the Secretary of Defense (OSD). Once the views of the National Security Council, the Joint Chiefs of Staff, and the Secretary of Defense on desired force levels have been examined and evaluated a Joint Force Memorandum or JFM is formulated and distributed to the Services [Ref. 15].

Receipt of the JFM by the services officially signals the beginning of the programming phase. In a continuos dialogue between OSD and the services the manpower, weapon system, and resource requirements necessary to obtain and mantain those forces as outlined in the JFM are considered. At the end of this phase OSD provides the services with Program Decision Memorandums which review all relevant opinions and decisions of OSD on military needs for the next five years. The end product of the programming phase is the Five Year Defense Plan (FYDP) which contains DoD's updated list of programs, program elements, force levels and attendant resources for the ensuing fiscal year and the

following four years. It should be noted that this phase emphasizes programs through coordination by the Secretary of Defense across service lines and the determination and evaluation of tradeoffs among programs and program elements.

Programming requires the full program cost concept, otherwise it is not possible to compare alternative uses of resources. Each program element is carried in the FYDP with a full breakdown of forces assigned to that element (for instance, if the element is Navy Tactical Air Force Wings, forces would be the number of squadroms). Full costs of investment or acquisition, research and development, and operations are further broken down into "appropriations" such as Procurement, and Operations and Maintenance.

The matrix shown in fig.5 will give you a general idea of how the FYDP is structured.

YEARS --→		PRIOR YEARS			C Y	B Y	OUT YEARS						
		62	70	71	72	73	74	75	76	77	78	79	80
FORCES --→				T	H	I	N	G	S				
R & D	RD T&E												
	MILCON												
	(TOTAL)												
INV	PROC												
	MILCON												
	(TOTAL)		D	O	L	L	A	R	S				
OPER	O & MN												
	PROC												
	MILPERS												
	(TOTAL)												
T O A													
MIL	OFFICER												
	ENLISTED												
	(TOTAL)		P	E	O	P	L	E					
CIV	U S												
	FOREIGN												
	(TOTAL)												

Figure 5 - FYDP STRUCTURE, AN EXAMPLE OF

Since the FYDP is both a record of historical costs and a program of future costs, costs are displayed in consonance with the year they represent: costs for the years prior to the current year are actual obligations; current year costs are actual when known, otherwise they are the programmed costs; budget year and out-year costs should reflect price indices or inflationary trends, except where controlled by law. The final phase, budgeting, occurs during the period from October through December immediately preceding submission of the budget to the Congress in January. Up to this point the budget has been considered in program format and must now be transformed into appropriation categories before being submitted to the Congress. This transformation (Known as crosswalking) is the process by which resources needed to support the program elements are aggregated into appropriation categories. As an illustration of this process, consider Figure 6. Determination of MILITARY PERSONNEL requirements-NAVY (MPN) involves going through all program elements in the Navy budget and summing their individual MILITARY PERSONNEL resource requirements. This sum represents the total NAVY MILITARY PERSONNEL funding needs. A similar procedure is followed to determine the other appropriation category requirements. A complete breakdown of Major Defense Programs and Congressional Appropriation Categories is included as Figure 7.

Once the program needs are crosswalked into the various appropriation categories they are forwarded to OSD and the office of Management and Budget (OMB) for review and integration into the President's Federal budget and subsequent submission to the Congress.

Completion of the formal PPB cycle in no way marks the end of DoD's consideration of its budget request. In reality, submission of the budget to Congress signifies the

beginning of a new dialogue; this time between the Congress and the Department of Defense. During the Authorization and Appropriation Committees' review of the defense budget a request for additional information on a specific line item (for example, Navy A-7E Attack Aircraft) or the impact of a reduction in funding for an entry program will generate further analyses of that line item by OSD or the service involved. This question and answer process tends to reveal the strengths or weaknesses of a request and the underlying desires of Congress.

After the legislative procedure has concluded in both the House and Senate with the determination of actual funding levels the final Defense Appropriation Bill will delineate the level of New Obligational Authority (NOA) allocated to the appropriation categories and represents an upper limit to which the Federal Government may be obligated by the Defense Department during the obligational period associated with a specific appropriations category (see Figure 7 for lengths of obligational periods).

The final phase of the budget cycle is conducted by the services after the defense budget is signed into law by the President. During this phase the Congressional allocations to the appropriation categories are crosswalked back into Defense budget format. If a specific program element has been cut by the Congress then that program is funded accordingly.

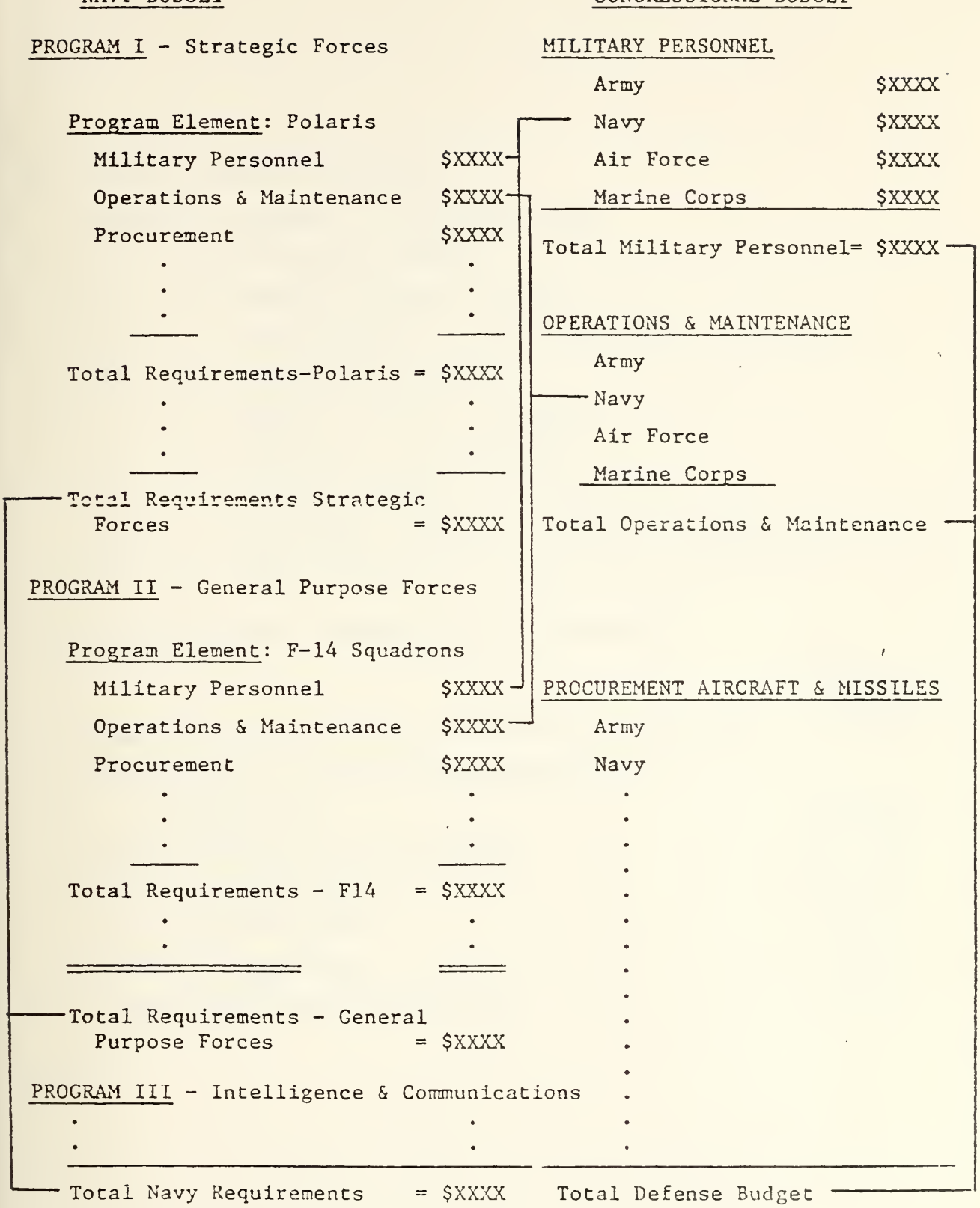

Figure 6 - "CROSSWALKING" THE DEFENSE BUDGET INTO CONGRESSIONAL APPROPRIATION FORMAT, AN EXAMPLE OF

A. MAJOR DEFENSE PROGRAMS

0(Zero)- Support of Other Nations
I ------ Strategic Forces
II ----- General Purpose Forces
III ---- Intelligence & Communications
IV ----- Airlift & Sealift
V ------ Guard & Reserve Affairs
VI ----- Research & Development
VII ---- Central Supply & Maintenance
VIII --- Training, Medical & Other Personnel Activities
IX ----- Administration & Associated Activities

B. CONGRESSIONAL APPROPRIATION CATEGORIES

	Obligational Period
Research, Development, Test and Evaluation	2 years
Procurement (except Shipbuilding and Conversion)	3 years
Shipbuilding and Conversion	5 years
Military Construction	2 years
Military Personnel	1 year
Reserve Personnel	1 year
Operations and Maintenance	1 year

Figure 7 - MAJOR DEFENSE PROGRAMS AND CONGRESSIONAL APPROPRIATION CATEGORIES; A LISTING OF

A. DEPARTMENT OF DEFENSE CONTROL OF THE BUDGET

The Secretary of Defense can exercise control in the very begining of the phase at the appropriations step and further extend this control through the allocation process, the obligation process and reprogramming activities; also transfers can be effective tools of control available to the Department of Defense.

Once the Defense Appropriation Bill is passed by the Congress, it is binding as to how much the DoD can obligate thereunder and, within its broad purposes, what can be bought.

The apportionment process, exercised through OMB, reflects Presidential control and can restrict the rate or purpose of obligations as provided by law. Apportionments are made on the basis of hearings conducted by OMB, office of the Secretary of Defense (OSD), and DoD components wherein apportionment requests are considered. This apportionment process also serves the important function of updating the budget which was submitted to OSD more than a year previously. Once the apportionment is released by OMB, it becomes the Secretary of Defense's authorized obligation rate.

The Secretary of Defense exercises his primary financial control by establishing the rate of obligations of funds for the DoD components based on the OMB apportionment release. Departments of the Army, Navy, and Air Force will submit to the Assistant Secretary of Defense Comptroller their proposed operating budgets and financial plans for review in anticipation of the formal submission of an apportionment

request based on the appropriations act.

Upon receipt of these plans and budgets, analysts from OSD evaluate in substantive detail and make their recommendations to the Comptroller based on evaluations of program proposals (feasibility, desirability, priorities, timing, etc.), procurement, and research and development line items. It is at this point that the Secretary of Defense can exercise additional financial control by deferring programs until later in the budget execution program. This is used to restrict the flow of funds, as well as to control programs by withholding funding authorization until complete justification is provided.

To meet changing needs, the Secretary of Defense has the authority, with the approval of the Office of Management and Budget, to transfer funds from one appropriation account to another if such transfers do not exceed statutory limits. There are four other methods besides the transfer authority available to OSD and the Department of Defense components which provide flexibility within appropriations. These are Supplemental Budget, Contract Authorization, Deficiency Budgets, and Reprogramming.

Supplemental Budgets and Deficiency Budgets are in essence additions to the annual budget proposed by the Secretary of Defense to request funds for major unforeseen emergencies during the current year.

The Secretary of Defense's funding authorization provides agencies with a document which establishes authorized funding levels; i.e., obligational authority for both direct and reimbursable programs for each appropriations and expense authority for military personnel of the Active Forces. Generally, this document establishes applicable program, budget activity, procurement line item,

and program element distributions of the total resources for the year. These documents are revised during the course of the year to reflect appropriation enactment, releases from deferral, reprogramming or other actions which affect the funding authority.

Agencies submit monthly reports to the Office of the Secretary of Defense reflecting the status of avilable funds. These reports are forwarded for review to the Office of Management and Budget and the House Appropriations Committee.

An annual report is prepared by the department Ccmptrollers and submitted to the Office of Secretary of Defense in December as the previous end-of-year (30 September) uncbligated and unexpended balances, as well as the unpaid cbligations, of all appropriations and funds. This report is submitted to the Treasury Department for establishing year-end balances and to withdraw or restore funds as necessary.

1. Allocation

Fcllcwing the establishment of the rate of obligation, which is quite an involved process, the Secretary of Defense allocates funds tc responsible officials in their organizaticns. These allocations are usually divided into sub-allocations, allotments, and sub-allotments or are included in operating budgets at the user level to make funds available for commitment, obligation and expenditure. A commitment is a reservation of funds based upon currently directed use leading to cbligaticns. An obligation is a liability; e.g., a firm contract for gocds or services. An expenditure is payment of the cbligation. Allocations, commitments, obligations,

and expenditures are carefully controlled to avoid overspending.

2. Obligations

A crucial step in the spending process exists in the obligation of funds. Many decisions regarding the timing of obligations are initiated at the agency level. If an agency fails to obligate by a certain time, the funding authority lapses and reverts to the Treasury.

In this respect many controversies still exist and legislation is usually changing to try to enforce its commitment.

3. Reprogramming

In the area of budgetary control within the Department of Defense, reprogramming is an effective technique of budgetary control in the execution process. Reprogramming is essentially a process of moving funds within a single appropriation account.

Congress appropriates lump-sum amounts to the Defense Department. It is the understanding of the Appropriations Committees and of the Congress that the monies will be spent in accordance with the original departmental justifications as appropriately amended.

As the budget year unfolds, new and better applications of money come to light. Reprogrammings are made for a number of reasons, including unforeseen developments, changing requirements, incorrect price estimates, wage rate adjustments, changes in the international situation, and

legislatien enacted subsequent to appropriations.

Thcugh reprogramming offers the Secretary of Defense an effective tool for preserving management flexibility, it also provides the cpportunity for substantial re-emphasis of policy. Cne such possibility is requesting funds for a popular program today, knowing Congress will provide the funds, and reprogram for a disfavored project tomorrow.

4. Transfers

The Department of Defense Appropriation Act contains language which grants to the Secretary of Defense authority, with the approval of the Office of Management and Budget, to transfer funds in the current fiscal year upon determination that such action is necessary and in the national interest. The transfer authority is normally stated as a dollar limitatien nct to exceed a specified amount available to the Department of Defense for military functions (except military construction). Transferred amounts are merged with and made available for the same purpose and time period as the appropriation or fund to which it is transferred. The Appropriation Act also provides the additional criteria that must be applied to the use of the transfer authority and to requests for cther proposed reprogramming actions. Transfers are not authorized unless for higher priority items, based cn unforeseen military requirements, than those for which originally appropriated and in no case where the item for which funds are requested has been denied by the Congress. The Secretary of Defense is required to notify the Congress promptly cf all transfers.

B. STRUCTURAL ASPECTS OF PPBS

The first step in PPBS is to identify and examine objectives. This objectives could emanate from a broad national purpose such as to defend our National Sovereignity. Towards such a goal, there are intermediate objectives such as National Defense, Social Development, and Economic Development. Under National Defense there are more concrete objectives in areas such as Air Defense, Naval Defense, Maritime Patrol. Under Air Defense, for example, there are specific objectives such as Fighter Squadrons, Cargo Aircraft, which result in a hierarchy of objectives.

A hierarchy of objectives is the criterion for the program structure. A program, in the PPBS sense, is an integrated activity-a combination of labor, material, and capital whose output is related to an objective[7] Accordingly, the activities are assembled by programs, sub-programs, and program elements at respective levels of aggregation.

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[7] See David Novick, "Which program do we mean in program budgeting?" The Rand Corporation, p.530, May 12, 1954. It emphasized that the program is also the primary unit for management and planning at the policy level.

The building of the program structure does not have to flow from top to bottom. It may be more practical to start from on-going programs which can be worked either upwards or downwards. Then the balance of activities may be aggregated upwards resulting in new identified programs.

After a program structure has been matched-out to the hierarchy of objectives, the outputs of the program categories are analyzed in terms of their respective objectives. This is done for more specificity if not quantification. For example, a Maritime Patrol program has operational output of patrol hours/day. However the real output of this program may be deterrence against any possible enemy incursion. But outputs of this nature are not easily measurable at all levels of the program hierarchy. Furthermore, maritime patrol may consist of an air and sea element, and, in this case operational outputs of activities or programs elements are mixed into program outputs of the next large grouping. Thus, analytical approaches have to be developed to be able to express the mixture of lower level outputs as an aggregated.

In recognition of this difficulty, the program outputs may only be quantified at the level of the program elements [Ref.3, pag. 25]. In this manner, the proposed expenditure data can still be related to performance. Program elements should produce clearly definable outputs, which are quantified wherever possible; and whenever feasible, the output should be an end product and not an intermediate product that supports another program element [Ref. 4, pag.3]. In the Defense case, air defense is an unmeasurable element, so, indirect measures have to be used, such as the number of CF-5 squadrons. After the possible measures of outputs are established, the desired output levels are determined. These levels of outputs and the alternatives to

attain them are major considerations of the program analysis. Nevertheless, PPBS does not start from nothing. There are statistical indicators accumulated in the existing budgeting, accounting, and information systems. The process of program structuring draws from data that may not have seemed important in the past. The program structure costed for a fiscal year is known within this context as the Program Budget.

These points can be summarized by looking at some characteristics of a program structure. These are shown in Fig.8 [Ref.5, pag.4].

Relates Objectives and Activities.

- Identifies objectives
- Provides measurables objectives
- Includes all activities
- Allows for growth (flexibility)

Supports Decisionmaking.

- Illuminates priorities
- Highlights trade-off areas
- Promotes realistic analysis
- Provides for imaginative change
- Is manageable

Figure 8 - CHARACTERISTICS OF A PROGRAM STRUCTURE

In general, these are the characteristics of a program structure that make a program structure, and the resulting program budget, a useful information display. Information is provided about what is being done and how the resources are allocated. The program structure allows for growth by providing stable goal-oriented programs that are sufficiently broad to encompass a wide variety of program elements (Mirage squadrons, Frigate Divisions for example) in the future, and it provides the basis for measuring how well program objectives are being met. This projection into the future may be called the Multi-Year Program Budget (MPB), or what was called Program and Financial Plan (PFP)[Ref. 6]. A PFP for five years is not to be confused with the budget proposal for five years, It is not a projection of future activities in the sense that decisions may be made to reduce, enlarge, or eliminate some program alternatives. The PFP projects the future implications of current budgetary decisions. It is not a prediction of future decisions.

This extended time horizon is important in investment decisions where the life-cycle costs of the equipment or asset must be considered. It also reminds the resource mobilizer and allocator that there are recurrent costs. These costs may be covered by existing legislation outside of the annual legislative process on the government budget.

To summarize, the structural aspects of PPBS consists of the hierarchy of objectives, program structure, program budget, and the multi-year program budget.

C. ORGANIZATIONAL DEVELOPMENT AND PPB

There are several assumptions underlying the use of Organizational Development (OD) and PPB for planning purposes. First, it is assumed that the employees (Military Personnel for our purpose) are considered to be valuable resources, and are managed as any other scarce resource within the military organization in the most effective way.

A second assumption is that while the PPB system will continue to use some prescribed methods, there will be an attempt to use more effective means for involving people in the organization. The analysis, program structure, and data collection phases of PPBS will remain the same, but the goal-setting and objective-setting aspects will be changed significantly and there will be some modification in the control phase.

A third assumption underlying the marriage of PPB and OD is that this approach to planning purposes will be systematic (system-wide) and pervasive (massive in scope) over time [Ref. 16, pag.43]. It would take a number of years to implement such a program, and PPB is pervasive in that it demands a very substantial organizational commitment, even calling for reorganization in some cases.

It is obvious that humans constitute the work force responsible for exercising efficiency and meeting organizational goals (one of the fundamental aspects of PPBS), therefore, using OD and PPB concurrently will allow for total systematic planning, and the dual approach addresses itself to both the data-related and people-related problems in the organization.

It is important in the goal-setting process that persons at all levels of the organization be involved in setting objectives appropriate to their own spheres of work. Invclving people in this way enhances their conmitment to the whole specific program and facilitates the future implementation.

Many planners within the Military Organization do not allow for a two-way goal-setting process. In the objective-setting stage of any particular program, those who participate are often required to set objectives within the goal parameters already established by those in the upper echelons of the hierachy. In other words, the emphasis is on relating one's objectives to the organization's goals, rather than on also considering the goals of those in the system and allowing them to influence the purposes of the organization. This rather limited form of goal-setting with its one-way thrust (downward) could tend to prevent subordinates from really "owning" the objectives they set.

This type of approach tends to be similar as that of the System Analyst, he usually is only concerned with the output of the organization; he makes recommendations as to the most effective utilization of resources to get a desired effect on the environment. His view of the inside of the organization tends to assume that information is the main thing moving upwards, while decisions about objectives, alternatives, and perhaps even techniques move downward [Ref.18].

Archibald [Ref.18] states the following characteristics of the system analysts view of organizations:

(1) There is a tendency toward elitism and/or centralization.

(2) The organization is primarily viewed as acting on its external environment.

(3) Systems Analysts usually don't talk about helping a client, rather they talk of improving decisionmaking.

(4) They are interested in the effectiveness of a decision.

(5) If the client does not accept their recommendations, they tend to assume that the client is of lower intelligence than them.

Related to two-way goal setting, there exists the concept of shared organizational control, that is, most human systems operate under conditions of change wherein it is impossible to completely legislate subordinate behavior, the military organizations being an exception to this rule, for there are very well established roles and responsabilities among its members and a relationship of trust exists between superiors and subordinates. Although the control system used by the military organization apparently conforms to a strict hierarchial control, it can be expected that many powerful persons in the organization--those who have already established their criteria (relative to a specific subject) - will oppose any program which changes their influence. Others may see the new method as an opportunity to gain influence quickly under new conditions.

Organizational controls originating from superior and conveyed downward to subordinates (e.g.,rules,processes) should be accompanied in effective organizations with meaningful upward (from subordinates to superiors) forms of influence and communication.

When control is one-way, there tends to be token compliance to the "letter of the law," overemphasis on the items to be measured and used as criteria, overemphasis on the short-rather than the long-run, covering up infractions of the rules and exercising other forms of dishonest behavior, and a reduction in subordinate creativity which comes from allowing discretion within which creative potential can unleashed [Ref.17, pag.381-385].

Another aspect that is worth mentioning is that most planning within the military context relies heavily on hierarchial control; superiors demand written objectives by a certain date, these objectives must conform to the rules for writing them. Subordinates are expected to comply with rather stringent system constraints and manage their own objectives within those parameters. The threat of a bad fitness report or unexpected change in duty station, or of losing a particular opportunity for promotion looms as a punishment.

This environmental climate provides Systems Analysts one way to achieve organizational goals creating some semblance of order "useful for action purposes". Thus it is the System Analyst who will say "Most of your time has to be spent in figuring out what the problem is."

Wildavsky [Ref.19] argues that Systems Analysts have tended to ignore people problems within organizations, or, to fit them into a rationalistic model. In the OD approach (or clinical approach as for Archibald), the clinical expert prefers to work with all levels of an organization during the course of his association with it. The decisions are not seen as being imposed from on high; rather decisionmaking is looked on as a participatory process involving many parts of the organization.

The characteristics of the Organizational Development approach have been described by Archibald as:

(1) There is a tendency to see the ideal decision-making process as participatory.

(2) The organization is primarly viewed as acting and reacting internally.

(3) The clinical expert talks about helping the organization to change.

(4) There is a tendency to be more concerned about the internal acceptability of decisions that about either their effectiveness or their political feasibility.

(5) The client is seen neither as stupid nor as responding rationally to pressures, but rather as a social system which because of its complexity has difficulties living up to its full potential.

In conclusion, a method for making human behavior in an organization more effective was presented, and a comparison with the System Analysis approach was established. This method known as Organizational Development when used in conjuction with PPE, could prove to be an effective way for planning system-wide changes and programs in military organizations.

IV. IMPORTANT FINDINGS

A. CONCLUSICNS

Military technology nowadays alone, would make necessary the central planning and direction of the military program. The technical complexity cf modern day weapons, their lengthy period of development, their tremendous combat power and enormous cost have placed an extraordinary premium on sound choices of major weapon systems. These choices have become, for the top management of the Defense Department, the key decisions around which much else of the Defense program revclves. They cannot be made properly by any subordinate echelon of the Defense establishment. They must be directly related to our national security objectives rather than simply to the tasks of just one of the military services.

The revclution in military technology must not only change the character of our military program, it must also, to a significant degree blur the lines of demarcation among the various services. Most of our major military missions today require the participation of more than one of the military services. Therefore, our principal concern now must he centered on what is required by the Defense establishment as a whole to perform a particular military mission-nct on what is required of a particular service to perform its part of that mission. This is not only true with regard tc the planning cf our military forces and programs, but also with respect to the procurement of new major weapon

systems.

Within the Venezuelan DoD, each military service in turn prepares its basic budget submission, allocating its request among its own functions, units, and activities, and present additional requests, by means of additional credits. Then all the budget submissions are reviewed together by the Minister of Defense's Budget Office.

This author believes that this procedure is a rather inefficient way to go about preparing the Defense budget. Among its consequences we can cite that each service tends to exercise its own priorities, favoring its own unique missions to the detriment of joint missions, striving to lay the groundwork for an increased share of the budget in future years by concentrating on alluring new weapon systems, and protecting the overall size of its own forces even at the cost of readiness.

Another unsatisfactory aspect of this method is the almost complete separation between budgeting and military planning. The planning horizon extends years into the future but the budget is projected only one year ahead. Military requirements tend to be stated in absolute terms, without reference to their costs. But the military effectiveness or military worth of any given weapon system cannot logically be considered in isolation. It must be considered in relation to its cost-and in a world in which resources are limited, to the alternative uses to which the resources can be put. Military requirements are meaningful only in terms of benefits to be gained in relation to their costs. Accordingly, resource costs and military worth have to be scrutinized together.

This author also believes that the existing system of programmatic and financial review is incapable of providing

all the information necessary to make decisions that have to be made.

The most significant findings found according to this author's criteria were:

First - no one really knows the total cost of a weapon system because the costs of its individual parts are characteristically scattered among a number of separate budget programs.

Second - rarely does a proposal identifiy and evaluate the future commitment of funds implied in the initial procurement decision. A new weapon system passes through stages of research and development; if it is put into operation, there is a requirement for trained personnel to run it, logistic support to maintain it, and facilities to repair it, at the very least, for as long as the system continues to be used. The costs of these activities, although clearly attributable to the weapon sytem, are not generally available to the decision makers.

Third - in the absence of full information as to total costs of entire programs over their lifetime, budgets are essentially conglomerations of piecemeal data, each representing an annual expenditure for a single fragment of an often unrecognized whole. Budget deadlines create pressures aggravating the woes of all concerned by shutting off any possibility of analysis in depth.

Fourth - there is no review system that can make comparisons between alternatives. For if the available data for each system is fragmented and incomplete, then obviously there could be no relative evaluations of competing systems.

Oversimplified though these statements may be, they do

B. AREAS SUGGESTED FOR FURTHER STUDY

(a) Time-series regression analysis has been used to investigate the applicability of the Davis, Dempster, and Wildavsky models to the Defense budgetary process. This author feels that questions have been raised about the validity of a model's statistical properties and test results when using linear models with a suppressed constant term. A survey of available theory on linear regression analysis revealed that few textbooks addressed the subject explicitly, and those that did, approached the topic in general terms. Further research in this area is required to establish the statistical properties of incremental models and appropriate test procedures.

(b) PPBS is not the only budgeting system used as a base for the budget formulation and preparation in governmental agencies. The search for different systems in this area with specific applications to the Venezuelan DoD, is suggested by this author.

(c) Techniques for implementing PPBS within the Venezuelan DoD should be investigated. This author feels that this is one of the most delicate aspects in the innovation of any type of idea or technique. Special attention should be given to this suggestion in order to achieve part of this thesis' initial intentions.

APPENDIX A

LINEAR REGRESSION THEORY

A. LINEAR REGRESSION WITH A CONSTANT TERM

Suppose that there are n observations (X_t, Y_t), $(X_{t+1}, Y_{t+1}), \ldots\ldots, (X_{t+n}, Y_{t+n})$ where X_t is defined as the independent variable and Y_t the dependent variable. Further suppose that after plotting these n observations a linear relationship of the form

$$Y_t = \beta_0 + \beta_1 X_t + \varepsilon_t \quad ; \; t=1,\ldots\ldots,n \tag{1}$$

where: Y_t and X_t are as previously defined

β_0 = the constant term

β_1 = the slope coefficient

ε_t = random error term (difference between actual and estimated value of Y_t)

is postulated.

The sum of squares of deviations from the regression line is

$$S = \sum_{t=1}^{n} \varepsilon_t^2 = \sum_{t=1}^{n} (Y_t - \beta_0 - \beta_1 X_t)^2 \qquad (2)$$

The objective of least-squares regression is to select $\hat{\beta}_0$ and $\hat{\beta}_1$ (estimators of β_0 and β_1) to be those values which, when substituted for β_0 and β_1, produce the least possible value of S. These values may be determined by differentiating equation (2); first with respect to β_0 and then β_1 and setting these results equal to zero. The solution to the two resulting equations (called Normal equations) is

$$\hat{\beta}_1 = \frac{\sum_{t=1}^{n} X_t Y_t - \left[\left(\sum_{t=1}^{n} X_t \right) \left(\sum_{t=1}^{n} Y_t \right) \right] / n}{\sum_{t=1}^{n} X_t^2 - \left(\sum_{t=1}^{n} X_t \right)^2 / n} \qquad (3)$$

and $$\hat{\beta}_0 = \bar{Y} - \hat{\beta}_1 \bar{X} \qquad (4)$$

Up to this point no assumptions that involve probability distributions have been made. If it can be assumed that, in equation (1)

a. ε_t is a random variable with mean zero and constant variance σ^2 (unknown); and

b. ε_t and ε_{t+1} are uncorrelated, $i \neq 0$

then the Gauss-Markov theorem insures that the least-squares estimators $\hat{\beta}_0$ and $\hat{\beta}_1$ are minimum variance, unbiased estimators in the class of estimators that are linear in the observations.

If it is further assumed that the ε_t's are

c. independently, identically distributed normal random variates with mean zero and variance σ^2, that is, $\varepsilon_t \sim N(0, \sigma^2)$

then $\hat{\beta}_0$ and $\hat{\beta}_1$ achieved the Cramer-Rao lower bound for variance of an estimator [Ref.7, pag.8-33].

B. LINEAR REGRESSION WITHOUT A CONSTANT TERM

If, instead of equation (1), suppose that the relationship

$$Y_t = \beta_1 X_t + \varepsilon_t \quad ; \; t=1,.....,n \tag{5}$$

is postulated for the data. The sum of squares of deviations from the regression line then becomes

$$S' = \sum_{t=1}^{n} \varepsilon_t^2 = \sum_{t=1}^{n} (Y_t - \beta_1 X_t)^2 \tag{6}$$

Minimization of S' yields only one Normal equation from which the estimator for β_1 may be derived.

$$\hat{\beta}_1 = \frac{\sum_{t=1}^{n} X_t Y_t}{\sum_{t=1}^{n} X_t^2} \tag{7}$$

Since there is but one Normal equation, the sum of the error terms ($\sum_{t=1}^{n} \varepsilon_t$) may or may not equal zero for linear regression without a constant.

The importance of this result becomes apparent when reviewing the assumptions outlined in section A. If the regression line naturally passes through the origin then β_0 and $\sum_{t=1}^{n} \varepsilon_t$ will be zero. If, however, the regression line does not pass through the origin and the constant term is suppressed then $\sum_{t=1}^{n} \varepsilon_t$ will not be zero. Should this be the case, the validity of assumptions a, b, and c is questionable.

APPENDIX B

STATISTICAL CRITERIA FOR TESTING LINEAR REGRESSION MODELS

A. SIGNIFICANCE OF ESTIMATED COEFFICIENTS

The t-statistic is used to test the statistical significance of a coefficient and is defined as the ratio of the difference between the coefficient's estimated and hypothesized value and its standard error; that is

$$t = \frac{\hat{\beta} - \beta}{\hat{\sigma}_{\hat{\beta}}}$$

[Ref.7,pag.37]. Theoretically the error terms need to be normally distributed with mean zero and constant variance. However, there are simulations which have shown "t" to be fairly robust towards distributional assumptions. Therefore, the "t" test will be considered valid for linear models with a suppresed constant.

B. COEFFICIENT OF DETERMINATION

Coefficient of determination or R^2 is a standard measure of "goodness of fit" for linear regression models and is defined as the proportion of (sample) variance (in the dependent variable) explained by the fitted regression line. When all the dependent variable observations in the sample

ccincide with the least-squares regression estimates R^2 equals one, a perfect fit. As the proportion of total variance that remains unexplained increases, R^2 approaches zero.

The usual computational formula for estimating P^2 for a data sample is

$$R^2 = 1 - \frac{\sum_{t=1}^{n} (Y_t - \hat{Y}_t)^2}{\sum_{t=1}^{n} (Y_t - \bar{Y})^2}$$

$$= 1 - \frac{\text{unexplained variation of the dependent variable about the regression line}}{\text{total variance of the dependent variable about its mean}}$$

[Ref.8, pag.45].

Replacing $(Y_t - \hat{Y}_t)^2$ by ε_t^2, the square of the error term for observation t, the formula for R^2 used here will be,

$$R^2 = 1 - \frac{\sum_{i=1}^{n} \varepsilon_i^2}{\sum_{i=1}^{n} (Y_i - \bar{Y})^2}$$

Stromberg [Ref.9, pag.21-42] has pointed out that the interpretation of $\sum_{i=1}^{n} \varepsilon_i$ as the (sample) unexplained variance is not correct for linear regression models without a constant term since $\sum_{i=1}^{n} \varepsilon_i$ may or may not be zero. Injecting $\bar{\varepsilon}$ into the expression for R^2 will not help since one could theoretically obtain a high coefficient of determination when the average error about the regression line is large but the spread about this average is small.

Stromberg and the BIOMED statistical package [Ref. 10] have addressed this problem by computing a somewhat different statistic. They have computed, instead, what Stromberg defines as W^2 where

$$W^2 = 1 - \frac{\sum_{i=1}^{n} \epsilon_i^2}{\sum_{i=1}^{n} Y_i^2}$$

$$= 1 - \frac{\text{unexplained variation of the dependent variable about zero}}{\text{total variation of the dependent variable about zero}}$$

The problem with this measure of goodness of fit is that zero and the regression line appears to have been chosen somewhat arbitrarily as the point about which the variation in the dependent variable is computed. Also, if is equal to or near zero (which will be the case if the computed intercept using a standard linear regression approach is zero) then with a positive Y (which is always the case with budget data) W^2 may yield a value considerably larger than R^2 and may be misleading to someone thinking in terms of R^2.

C. STANDARD ERROR OF ESTIMATE AND COEFFICIENT OF VARIATION

Another measure of dispersion about the regression line is the standard error of the estimate (SE) and may be determined by using the formula

$$SE = \sqrt{\frac{\sum_{i=1}^{n} (Y_i - \hat{Y}_i)^2}{n-k}}$$

where: n = the number of sample observations

k = the number of parameters being estimated in the regression

[Ref.7, pag.129]. The numerical value of the standard error of estimate is inversely related to the goodness of fit of the model.

It is somewhat difficult, however, to determine the significance of the standard error of estimate when comparing different sets of data. For this reason it is useful to compute a relatively standard error of estimate. The coefficient of variation (CV) is such a measure since it relates the standard error of a particular model to the mean value of the dependent variable, i.e.

$$CV = \frac{SE}{\bar{Y}}$$

A value of less than 0.20 for the coefficient of variation for a model is frequently cited as desirable [Ref.8,pag.44]. One particularly desirable characteristic of both the standard error of estimate and coefficient of variation is that they are not dependent upon any distributional assumptions of errors terms.

APPENDIX C

NONPARAMETRIC CRITERIA FOR TESTING LINEAR REGRESSION MODELS

A. THE MANN-WHITNEY U TEST

The Mann-Whitney U test may be used to test whether two data sets have been drawn from the same population and is useful when underlying distributional assumptions are questionable.

First, suppose that there appears to be two distinct sets of data; set A of size n and set B of size m. To test the null hypothesis that both sets are from the same population against the alternative hypothesis that they are not, the sample observations are ranked in order of increasing size; that is, assign the rank 1 to the smallest value in the combined sample, the rank 2 to the next smallest, and so on to the largest, which receives the rank n+m. Let $R(X_i)$ and $R(Y_j)$ denote the rank assigned to the set of values from population n and m respectively.

The value of the U statistic is computed by the formula:

$$T = S - (n)(n+1)/2$$

where S = the sum of ranks assigned to the observations from population 1. That is,

$$S = \sum_{i=1}^{n} R(X_i)$$

[Ref.11, pag.224]. Reject the null hypothesis at the level of significance α if T is greater than $1 - \alpha/2$ quantile $U_{1-\alpha/2}$ or less than the $\alpha/2$ quantile $U_{\alpha/2}$.

B. THEIL U-STATISTIC

The Durbin-Watson test and examination of residual plots provide insight into identifying problems of misspecification and bias, respectively. However, in the case of of small samples (as in budget data for DoD) these techniques are often inconclusive. Also, the Durbin-Watson test requires that the sum of the error terms equal zero.

As an alternative means of identifying bias and/or misspecification in a model with a suppressed constant term Theil's methodology for comparing estimates and actual observations was considered [Ref.12, pag.19-32].

Theil uses the idea of mean square error (MSE) in defining an inequality coefficient U as

$$U = \sqrt{\frac{\frac{1}{n}\sum_{i=1}^{n}(P_i - A_i)^2}{\sum_{i=1}^{n} A_i^2}}$$

where: A_i = the actual value of observation i

$P_i = \hat{A}_i$ (the predicted value of A_i)

Next, the numerator of U is decomposed in the following manner:

$$\frac{1}{n}\sum_{i=1}^{n}(P_i - A_i)^2 = (\bar{P}-\bar{A})^2 + (S_p - S_a)^2 + 2(1-r)S_p S_a$$

where :

$$\bar{P} = \frac{1}{n}\sum_{i=1}^{n} P_i \qquad \bar{A} = \frac{1}{n}\sum_{i=1}^{n} A_i$$

$$S_p = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(P_i - \bar{P})^2} \qquad S_a = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(A_i - \bar{A})^2}$$

$$r = \left[\frac{1}{n}\sum_{i=1}^{n}(P_i - \bar{P})(A_i - \bar{A})\right]/S_p S_a$$

The first term $(\bar{P}-\bar{A})^2$ will be zero if and only if the average predicted value equals the average sample value. Positive values of the first term will be errors of central tendency or bias. The second term $(S_p - S_a)^2$ will be zero if and only if the standard deviations are equal. Positive values for this term indicate errors of unequal variation. The third term $(2(1-r)S_p S_a)$ is zero if and only if the correlation coefficient between the predicted and actual values (r) is one (that is, if the predicted values always account for variations in the actual values) or if S_p and/or S_a equal zero, a degenerate case.

A more convenient way of expressing this decomposition is to standardize it by dividing all terms by their sum. Thus

$$U_b = \frac{(\bar{P}-\bar{A})^2}{\frac{1}{n}\sum_{i=1}^{n}(P_i-A_i)^2}$$

$$U_m = \frac{(S_p-S_a)^2}{\frac{1}{n}\sum_{i=1}^{n}(P_i-A_i)^2}$$

$$U_r = \frac{2(1-r)S_pS_a}{\frac{1}{n}\sum_{i=1}^{n}(P_i-A_i)^2}$$

U_b, U_m, and U_r may be characterized as inequality proportions where U_b is the bias proportion; U_m the variance proportion; and U_r the covariance proportion. Obviously $U_b+U_m+U_r=1$.

If the above inequality proportions are to be of value they must provide some insight into the quality of the estimating relationship being evaluated. The term, U_b, should be close to zero since least-squares estimation techniques are used to derive coefficient estimates. A high value of U_m indicates that the variance of the independent variable has not been properly accounted for. In such a case a search for other explanatory variables is in order. In other words, the regression equation is not properly

specified. A high value of U_r (along with low values of U_b and U_m) indicates that the equation is unbiased and properly specified, but the inherent variation in the independent variable cannot be completely explained[Ref.13].

While the preceding discussion is brief it does point out the problems with testing incremental regression models. Additionally, no single criteria is a reliable test of the postulated models. Therefore, the outcome of all of the test statistics will be used to evaluate the data selected to test the postulated decision rules.

APPENDIX D

TABLES OF RESULTS

MODEL :	R1	R2	R3
α_1 / β_1 : (t-value)	0.969 (29.581)	1.001 (30.314)	0.988 (26.925)
α_2 / β_2 : (t-value)			-0.583 (-1.130) *
SE :	36.3117	35.4455	35.9310
CV :	0.1261	0.1231	0.1248
W^2 :	0.9854	0.9861	0.9868
$\bar{\epsilon}$:	2.2262	2.0622	1.8393
U_b (%) :	0.4	0.36	0.31
U_m (%) :	0.007	0.01	0.08
U_r (%) :	99.593	99.63	99.61

* indicates that the variable may not be considered statiscally different from zero.

Table I - SERVICE DECISION MODELS RESULTS

MODEL :	A1	A2	A3	A4
α_1 / β_1 :	1.032	0.973	1.031	1.032
(t-value)	(59.624)	(5.651)	(53.400)	(53.757)
α_2 / β_2 :	--	-0.099	-0.032	-0.072
(t-value)		(-0.098) *	(-0.199) *	(-0.440) *
SE :	19.2892	21.4208	20.7385	20.6066
CV :	0.0651	0.0721	0.0698	0.0693
$\bar{W}^2$:	0.9961	0.9960	0.9959	0.9959
$\bar{\epsilon}$:	0.5021	0.3977	0.4458	0.3690
U_b (%) :	0.07	0.04	0.04	0.04
U_m (%) :	0.22	1.31	1.28	1.78
U_r (%) :	99.71	98.65	98.68	98.18

* indicates that the variable may not be considered statiscally different from zero.

Table II - CONGRESSIONAL DECISION MODELS RESULIS

A. RESULTS OF MANN-WHITNEY TESTS FOR DATA HOMOGENEITY

The Mann-Whitney U test was used to test data homogeneity in Service's request for the periods FYs 1962-1970 and FYs 1971-1976. The reason behind this separation in periods arose because of the adoption of a program denomination in the budget presentation since 1970. Under the null hypothesis the data subsets are drawn from the same population (H_0: $G(x) = F(x)$). To test this hypothesis against the alternative hypothesis that they are not from the same population (H_1: $G(x) = F(x)$) we used a two tailed test with a significance level of .05, and the following result was found:

a. FYs 1962-1970 vs FYs 1971-1976

$S = 56 \qquad T = 11$

$U_{(9,6,.025)} = 11 \qquad U_{(9,6,.975)} = 43$

(H_0 cannot be rejected)

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